

ES-SO CLAIMS SUBSTANTIAL ENERGY SAVINGS FROM SOLAR SHADING

SCIENTIFIC FEASIBILITY STUDY SHOWS LARGE CONTRIBUTION TO REDUCTION OF GREENHOUSE GASES AND TO SAVING MILLIONS OF TONS OF COSTLY OIL

WHO IS ES-SO?

ES-SO, the European Solar-Shading Organization (www.es-so.org) is the umbrella trade organization for the solar shading industries in the EU's 25 member states. ES-SO promotes the interests of the European solar shading and shutter industry and provides permanent contacts between its members. ES-SO also intends to communicate with the European authorities – Commission, Parliament and Council — in order to show how solar shading can lead to substantial energy savings in buildings and, therefore, to reduced CO₂ emissions, which helps the EU reach its Kyoto and energy efficiency objectives. ES-SO will demonstrate that solar shading enhances indoor comfort, which is to the benefit of productivity and competitiveness. The solar shading industry in Europe is essentially a SME (small and medium-sized enterprise) industry, employing at least 400.000 people in thousands of companies, with a total annual sales volume in excess of 15 billion euro. The high growth potential in this industry can provide thousands of new jobs, widely spread over all the member states, because the industry essentially supplies made-to-measure products to local markets.

BUILDINGS ARE LARGE ENERGY USERS

The environment, sustainability and energy are subjects that are high on the political agenda in all European countries. By 2012, the emission of greenhouse gases in Europe should be reduced by 8% below 1990 levels according to the Kyoto Protocol. Steeply rising oil prices have brought Europe's fragile dependence on imported energy sources to renewed and acute attention. The Lisbon agenda of the Commission strives for 'jobs and growth' and energy issues play a large role in that debate: products that use less energy will be more competitive and industries that achieve this will generate more new jobs.

Buildings are the largest energy-user in the EU. In excess of 40% of Europe's total primary energy consumption goes into their construction and operation – more than industry or transport consume. That explains why the European Commission issued the Directive on the Energy Performance of Buildings (EPBD). This Directive stimulates Member States to find ways and means to reduce the energy consumption of buildings by more than 20%. Every potential source of energy savings will have to be tapped and no opportunity can be left unattended to reach this goal. Since the energy crisis of the early seventies, insulation of houses and commercial buildings certainly has received the greatest attention and has led to substantial energy savings. But insulation alone is not sufficient. As architects like transparency and use more clear glass, the larger glazed surfaces become the weak spots of the building, because of the risk of excessive overheating in the summer. The answer often is the installation of costly and energy-consuming air conditioning units. The stormy growth of these artificial cooling systems in the energy consumption pattern is indeed a source of major concern: it is often a solution to a problem that could – and should – have been avoided or contained by the use of a proper solar shading system.



BENEFITS OF SOLAR SHADING IN ALL TYPES OF BUILDINGS

Solar shading, including shutters and roller shuttersⁱ, contributes to the reduction of energy demand of buildings in all seasons:

- During the heating season, by reducing the heating demand especially in wintertime due to the extra thermal insulation they provide, when in closed position, and by the optimum use of free solar gains through the windows in the autumn and spring with the solar shading in a controlled, open position
- In summertime, by reducing the cooling energy demand by avoiding solar heat gains due to excessive solar energy entering through the glazed parts of the buildings.



The solar shading and shutter industry offers a very wide variety of products. Only a few are shown here.

In this example, the top floor is equipped with external fallarm awnings, while the ground floor has internal roller blinds.



This house has a folding-arm awning to provide shadow on the patio. The other windows are equipped with external roller blinds.



Wooden external venetian blinds: Gaùdi knew a thing or two about controlling solar energy.



MEASURING HOW MUCH ENERGY CAN BE SAVED, HOW MUCH CO2 CAN BE AVOIDED

1. BUILDING SIMULATIONS

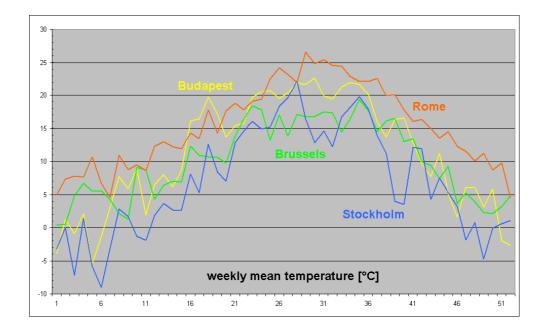
For the study commissioned by ES-SO, the energy demand reduction and the corresponding reduction in CO₂ and oil consumption due to solar shading are quantified by using building simulations. These are numerical simulations of the heat transfer in buildings under real climate conditions, using realistic user comfort demand conditions. Obviously, the thermal behavior of a building is the result of quite a number of parameters: the climate, the façade, the glazed surface, the roof and floor construction, the orientation of the building, its use, and many more. In this study, the simulations are in accordance with European and ISO standards and have been calculated for a set of representative combinations of the parameters. This allows a reliable conclusion about the energy demand reduction from solar blinds and shutters for the existing building stock in the EU-25.

2. SIMULATION PARAMETERS ASSUMED

Many parameters affect the energy consumption of a building. The less important parameters have been assumed at a fixed value, while seven (7) parameters have been chosen as significant for the building's energy behavior, in view of the effect of solar blinds and shutters. These are:

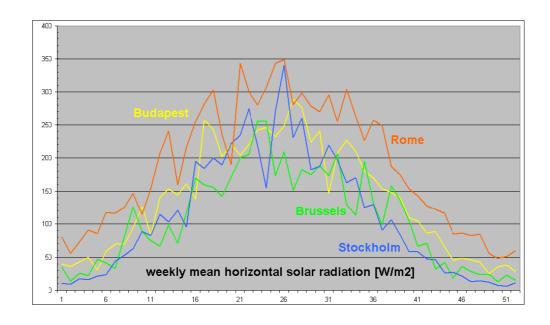
- Two (2) types of building <u>envelope</u>: one with only one external façade, one with two external façades. The first assumption is associated with a room in an apartment block or an office in a large building, while the second represents stand-alone houses or offices with windows at different sides of the building.
- Two (2) building <u>orientations</u>: south-west (where the evening sun is predominant) and north-east (where the morning sun is predominant).
- Two (2) <u>user profiles</u>: one representative for a residential situation (comfort from 8 am to 10 pm, seven days a week, low internal heat gains), one for an office condition (higher internal gains and comfort from 9 am to 6 pm, five days a week).
- Two types (2) of <u>windows</u>: one to represent a renovated building with double glazing (U = $2.6 \text{ W/m}^2\text{K}$, g = 0.63)ⁱⁱ, the other with new, high thermal quality windows in new or existing buildings (U= $1.8 \text{ W/m}^2\text{K}$, g = 0.63)ⁱⁱⁱ
- Two (2) types of <u>air permeability of the solar shading of the windows</u>. According to the EN ISO 10077 classification, the choice was made for the 'high permeability' as being typical for a <u>roller blind</u>, while the 'low permeability' can be associated with a <u>shutter</u>,
- Two (2) <u>positions</u> for blind or shutter: externally or internally positioned to the window. The internal position of a low permeability system ('shutter') can be associated with the use of closed curtains.
- Four (4) <u>climates</u>: to have a representative sample collection of the European climate conditions, we chose Brussels as typical for a moderate sea climate, Budapest, warmer in summertime, Rome as the warmer climate and Stockholm for its colder winters and brighter summers. The climatic data comprise the hourly temperature values and global and diffuse horizontal radiation from the reference years. It is interesting to note that the weekly mean values do not differ too much between Stockholm and Rome, and that the amount of solar energy is high in spring and fall, which eliminates one common prejudice: that solar shading is just for warmer countries, and mainly for the summer season





The graph above shows the mean temperatures per week, over the course of one year, for the four climates considered.

The graph below shows the total amount of energy per week on a horizontal surface, for the four climates considered. Note the amount of solar energy in Stockholm is not so much mower than in the warmer climates.





3. BUILDING SIMULATION PROGRAM AND SELECTION OF CASES.

The program used for the simulations is CAPSOL by Physibel^v. This program is validated according to ISO/FDIS 13791 "Thermal performance of buildings – Calculation of internal temperatures of a room in summer without mechanical cooling – General criteria and validation procedures".

The variable parameters listed in previous paragraph result in 256 different possible scenarios. From these, twenty-four (24) were selected in such way that the results allow the comparison of the effect of all the parameters on the energy demand for heating and cooling. For each case, two calculations are done: one without blinds or shutters, the other with (controlled) blinds or shutters.

A realistic assumption was made about the required level of temperature expected by the user. For the heating season in the residential application, a target temperature of 20°C has been assumed from 8 am to 22 pm, seven days a week, while in summertime, allowing 24°C for the same period. For the office conditions, the wintertime temperature has equally been assumed at 20°C from 9 am to 6 pm, five days a week, while allowing 24°C in summertime. For both the residential and office situation, outside the time limits mentioned a temporary increase to 30°C could be possible. The assumed internal temperature scheme implies that besides heating, cooling is part of the building simulation.

4. SIMULATION RESULTS

The study leads to a great number of quantifications for all cases considered. These include following calculated results and subsequent conclusions:

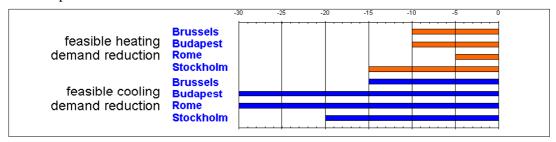
- the yearly energy demand for heating with and without blinds or shutters in kWh/a
- the yearly energy demand for cooling with and without blinds or shutters in kWh/a
- the difference in energy demand for heating and cooling per m² per year expressed in kWh/m²a
- the difference in energy demand for heating and cooling with blinds or shutters, as a percentage of the demand without blinds or shutters -- in other words the energy savings, as a percentage (%) from blinds and shutters
- the decrease in energy demand for heating as a result of the use of closed shutters in wintertime, in the order of 10%. Blinds do not help in this area, they are not intended to.
- the comparison between the energy savings in the various climate areas: logically, the highest savings are obtained in the Rome and Budapest climates on the south-west orientation when external shading systems are used. These savings amount to approximately 40 kWh/m²a.
- the effect of blinds and shutters is more important in buildings with low compactness and with greater glazed areas
- external blinds and shutters show a much better performance when it comes to reducing the cooling demand. Even in northern regions (Stockholm), the decrease is considerable
- even for north-west orientations, the reduction of cooling demand is important
- the effect of shutters on the heating demand is higher in residential buildings than in offices, because of the longer heating periods in houses and apartments and the greater internal heat gains in offices
- the thermal transmittance of the window (the U-value) has little effect on the cooling energy demand.



5. HOW BIG IS THE ENERGY SAVINGS POTENTIAL IN THE EU?

The results of the 24 scenarios, each time with and without solar shading device, have then been converted into global, EU-wide figures, as percentages and in absolute figures of potential energy savings and reduced oil consumption.

• First of al, the relative savings, in %, for the four climates areas have been graphically represented as follows:



- The second step is to associate all EU-25 countries to these four climates. That has been done by assigning each EU country to one of the climates considered. For instance, the Brussels climate ('west') is applied to Denmark, France, Germany, Ireland, Luxembourg, The Netherlands and the UK. In the same way, the climates of Budapest, Rome and Stockholm are applied to the remaining countries, each according to logic and science.
- Then, the number of inhabitants for each country, drawn from official EU sources (www.eu.2004.ie) has been multiplied by the floor area per inhabitant, drawn from an Ecofys study and the European Commission's Green Paper on Energy Efficiency. This results in a total number of heated or cooled square meters available in the EU.
- The next step is to determine a 'blind or shutter applicability factor'. Not every window in the whole EU will ever get a solar shading device. In some cases, blinds or shutters are of no interest, like for naturally shaded buildings (trees, tall buildings next door) or for buildings that need neither heating nor cooling, like some storage areas. The factor has been assumed as being 0,5. That means that we have assumed that it could be feasible that one window out of two would receive a blind or shutter. This results in a total kWh/m²a figure for reduced energy demand.
- Now we must apply a 'system efficiency' factor for the heating and cooling installations. For the heat production itself, a system efficiency of 0,8 is considered, for the cooling systems, a number of 0,71 based on a COP = 2 (Coefficient of Performance) and a conversion factor electricity/fuel of 2,8 (derived from 2/2,8 = 0,71).
- In order to reach potential CO₂ savings figure, an average CO₂ emission factor is applied (value from Ecofys report mentioned). By doing this, kWh/m²a figures result in millions of tons of CO₂ saved per year (MT/a). The total is 31 Mt/a for the reduced heating demand and 80 MT/a for the reduced cooling demand, for a potential total of 111 Mt/a of CO₂ savings. This should be compared to the total CO₂ emissions of the EU15 (before the accession of the ten new member states of 678 Mt/a and the effect expected from the EPBD as it stand now of 34 Mt/a to 44 Mt/a at EU-25-level.
- With the help of an internationally accepted conversion factor from energy demand to Mtoe (1 MToe = 11,63*10⁶ MWh), the potential reduction of oil consumption is now calculated. The figures are, respectively, 12 Mtoe/a for the reduced heating demand, and 31 MToe/a for the reduced cooling demand, for a total of 43 MToe/a. To put this in the right perspective, the number can be compared to the total oil consumption figures indicated by the European Commission in May 2005 of 1140 Mtoe/a energy end use, all sectors combined, of which 455 MToe/a for the EU-25 building sector.



CONCLUSIONS

In several reports, strong and convincing arguments have been made that better thermal insulation of buildings will increase energy efficiency and contribute considerably to the goals of the Kyoto Protocol. Among the various measures, improved glazing has been repeatedly recommended, along with more insulation. Glazing, however, remains a static element in the building's envelope, while the outdoor climate conditions alter with the seasons and can vary considerably in the course of a day. Solar shading devices, preferably controlled, mobile and automated, will make the solar transmittance through the windows dynamic and adaptable. In that way, both the cooling energy demand in summer and the heating demand in winter can be substantially reduced, by making good use of free solar gains, when they are welcome – in winter – while avoiding overheating in summertime.

This scientific study of ES-SO shows that, with a number of reasonable assumptions, the feasible energy savings and carbon emission reduction from solar shading are very significant and represent an important part of the targets set by the European Commission. The study also shows that solar shading is useful – needed – in all seasons and all climates. In the northern countries, with their long summer days and low standing sun, solar shading helps to take optimum advantage of the great quantities of free solar energy striking the windows. In the southern countries, solar shading helps to block the excess solar heat, reducing substantially the need for large air conditioning installations. In the middle of Europe, as the Brussels and Budapest climates show, the total solar energy in spring and autumn are high and both fee solar heat gains and reduced cooling loads justify the systematic use of solar shading in every efficient building.

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The term 'solar shading' covers a great number of solar control and window covering products, ranging from external roller blinds and external Venetian blinds, over sophisticated external louver systems and the many internal solutions like Venetians, pleated blinds, roller blinds, roman shades, Japanese panels etc., to simple internal curtains and other residential products. These can vary in degree of operation from simple manual (crank, cord, etc). to fully automated operation, taking into account time, weather conditions and temperature. Obviously, the fully automatically controlled systems result in the highest efficiency, because they also perform properly when the building is not occupied.

The U-value is the 'thermal transmittance'. This is the measure of how well the product insulates: the amount of heat loss relative to the indoor/outdoor temperature differential, expressed as $U = W/m^2K$. The reverse is R, or thermal resistance or RC, expressed in m^2K/W .

[&]quot;The g-value of a solar blind or type of glass is the 'total solar energy transmittance'. It is the total energy that enters the building, in the range of 300-2500 nm, relative to the total incident energy on the glazing (or window or fabric or blind). It is expressed as a % or proportion e.g. g-value 0,15 or 15%. It is also called the 'solar heat gain factor'.

Standard EN ISO 10077-1 defines five (5) air permeability classes: very high, high, average, low and very low. A roller blind usually is equipped with a fabric that allows high permeability, like glass fiber fabrics or other transparent fabrics. A shutter (like a roller shutter) will obviously qualify as a low permeability product.

www.physibel.be